Elements of Ambient Air Network Design

SC Department of Health and Environmental Control
Bureau of Environmental Services
Bureau of Air Quality
March 15, 2006

Housekeeping

Why we're here

– **Network developed over time**

Why we're here

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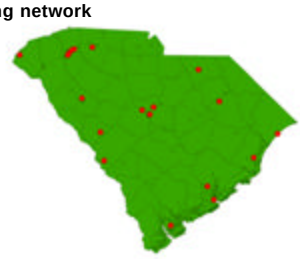
  - **$PM_{2.5}$ the most recent statewide 'ground-up' monitoring network**



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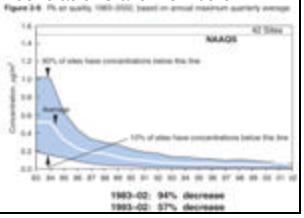

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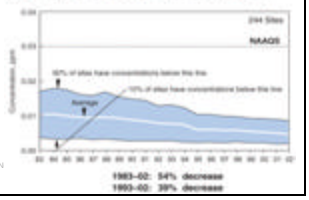

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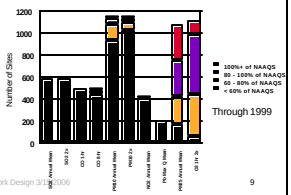

Through 1999

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- Needs have changed since the different parts of the network were developed
  - Some pollutant concentrations are well below health standards
  - Monitoring for those parameters may now serve a different purpose - different questions require different design
  - Original objective may still be a concern

Why we're here

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Why we're here

- Network developed over time
- Needs have changed since the different parts of the network were developed
- **Specific questions need answers to be able to continue to meet the standards**
  - **What are the significant sources?**
  - **Are the strategies having having an impact?**

Why we're here

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- Specific questions need answers to be able to continue to meet the standards
- **Proposed changes to ambient air standards and monitoring requirements**

Why we're here

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- Needs have changed since the different parts of the network were developed
- Specific questions need answers to be able to continue to meet the standards
- Proposed changes to ambient air standards and monitoring requirements
- **The required network may not be enough…**

Don't plan to talk about :

- **Specific Pollutants**
- **Specific Areas**
- **Specific Sites**
- **Specific Monitoring Methods**
- **Specific Guidance**

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…other than as examples to illustrate an element of Network Design.

Ambient vs. other monitoring

- **Is**
  - **Potential public exposure**

Ambient vs. other monitoring

- **Is**
  - **Potential public exposure**
- **Is usually**
  - **Parameters that have standards**

Ambient vs. other monitoring

- **Is**
  - **Potential public exposure**
- **Is usually**
  - **Parameters that have standards**
- **Is not**
  - **Indoor**
  - **On facility grounds**

Outline of approach

Briefly…

- **What we monitor**
- **Why we monitor**
- **How we monitor**
- **Elements of Network Design and Review**
- **Practical considerations**
- **Next steps in the review of the SC Ambient Air Monitoring Network**

Conventions and Resources

- **A Network is ...**
- **Monitor vs. Sampler**
- **Required, extra and things in proposed rule**
- **There WILL be acronyms**
- **References**
  - **DHEC Web Site**
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Questions ?

Questions !

Questions drive monitoring design

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State the Problem….

Objectives…

Questions !

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State the Problem….

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Questions drive monitoring design

Well defined questions dictate the What, Where, How often, and How long of Monitoring Network Design ..

WHAT

What we monitor

- Criteria Pollutants
  - National Ambient Air Quality Standards
- Noncriteria Pollutants
  - Everything else that may be a problem..
- Related parameters

  …or may be of interest and help us understand.

Standards

Criteria Pollutants have NAAQS

- Health is Primary
  - Based on the latest studies
  - Protective of sensitive populations
  - Address acute and chronic exposure
- Welfare is Secondary
  - Same as above, but…

    …for the environment and property

NAAQS

National Ambient Air Quality Standards

- **Sulfur Dioxide** SO_2
- **Nitrogen Dioxide** NO_2
- **Carbon Monoxide** CO
- **Ozone** O_3
- **Lead** Pb
- **Particulate Matter less than 10 microns** PM_{10}
- **Particulate Matter less than 2.5 Microns** $PM_{2.5}$

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- **Particulate Matter less than 10 microns** PM_C
- **Particulate Matter less than 2.5 Microns** $PM_{2.5}$
- **Particulate Matter less than 10, but greater than 2.5 microns** $PM_{10\text{-}2.5}$

SC Standards

State Ambient Air Quality Standards

- **Total Suspended Particulate** TSP
- **Gaseous Fluorides (as HF)** F^-
- **Ozone (1 Hour)** O_3

- **Sulfur Dioxide** SO_2
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Other Parameters

- **Pollutants**
- **Toxics**
  - **Organic compounds**
  - **Volatiles**
  - **Semivolatiles**
  - **Carbonyls**
  - **Metals**
    - **Mercury**
    - **Chromium^{+6}**

Other Parameters

- Pollutants
- **Effects**

- **Acid Precipitation**
- **Visibility**
- **Soiling**

Other Parameters

- Pollutants
- Effects
- **Components**

- **Components of fine particulate**
  - **Speciation**
    - ***IMPROVE***
    - ***STN***
  - **Monitoring**
    - **Sulfate**
    - **Black Carbon**

Other Parameters

- Pollutants
- Effects
- Components
- **Precursors**

- **Ozone**
  - **Oxides of Nitrogen NO_2, NO_x, NO_y, NO**
  - **Reactive Hydrocarbons**
- **Particulate**
  - **SO_2**
  - **NO_2**
  - **NH_3**
  - **Hydrocarbons**

Other Parameters

- Pollutants
- Effects
- Components
- Precursors
- **Supporting Information**

- **Meteorology**
  - **Wind Speed, Direction**
  - **Temperature**
  - **Humidity**
  - **Insolation**
  - **Upper air …**
- **Traffic counts**
- **Local events**

Questions !

Questions drive monitoring design

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- **Pollutants**
- **Effects**
- **Components**
- **Precursors**
- **Supporting Information**

WHY

To answer questions (Provide data for…)

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Do we have a problem? :

(Comparison to the standards)

- **NAAQS set to be protective of public health**
- **most sensitive populations**
  - **maximum concentrations**
  - **highest concentrations in areas with high population density**

To answer questions (Provide data for…)

Is Air Quality getting better or worse? :

(Tracking)

- **long term trends**
- **impacts on communities**
- **effectiveness of programs**
  - **impacts of sources or source types**
  - **maximum concentrations**
  - **highest concentrations in areas with high population density**

To answer questions (Provide data for…)

What is contributing to Air pollution ?:

(Investigation)

- **sources**
- **precursors**
- **interactions**
- **complaints**
- **impacts of sources or source types**

To answer questions (Provide data for…)

Can we predict the Future:

(Modeling support)

- **Data for input**
- **Data to test**
  - **spatial distribution**
  - **rural areas**
  - **background**
  - **transport**

Why we monitor

To answer questions (Provide data for…)

Can we document an impact (PSD):

(Confirmation)

- **Monitor before**
- **Monitor after**

To answer questions…Provide data for

- **Comparison to the standards**
- **Tracking**
- **Investigation**
- **Confirmation**
- **Modeling support**

To meet these needs, we monitor:

- **Max concentration**
- **Max exposure to population**
- **Impacts of sources**
- **Transport**
- **Rural areas**
- **Pristine areas (Background)**

HOW

Samplers

- **Sensitive**
- **Inherent average measurement**
- **Sample must be collected and analyzed**

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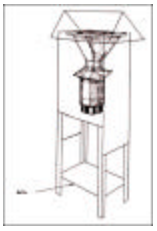

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Monitors

- **Fast response**
- **Data immediately available**
- **Data can be aggregated to longer time periods.**
- **Complex and expensive , but..**

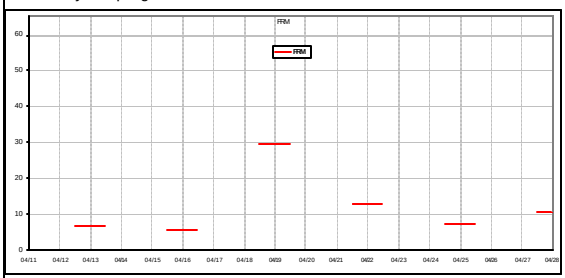
Monitors

- **Complex and expensive , but..**

…the details can be important.

Monitors

1:3 day sampling



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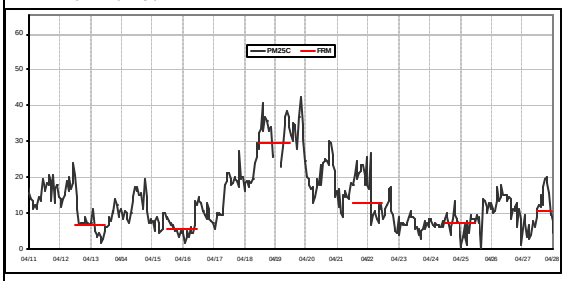
Monitors

1:3 day sampling plus continuous



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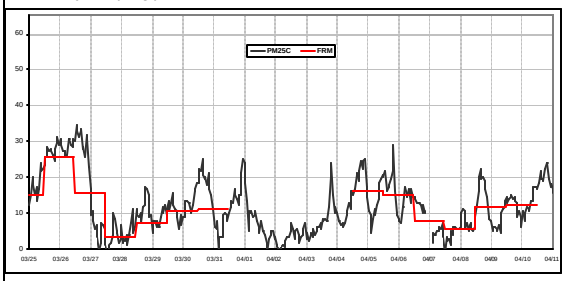
1:1 day sampling plus continuous



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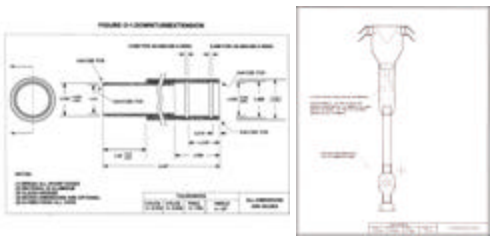

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The South Carolina Network uses Reference or Equivalent methods whenever possible

Standard methods for noncriteria pollutants

- Be part of national networks
  - Standardized methods
  - Quality Assurance
  - Data Management, Analysis and reporting
  - Designated funding may be available

Standard methods for noncriteria pollutants

- Be part of national networks
  - NADP / MDN
    - National Air Deposition Program/Mercury Deposition Network
  - IMPROVE
    - Interagency Monitoring of Protected Visual Environments
  - NAATS
    - National Ambient Air Toxics Sites

Standard methods for noncriteria pollutants

- Be part of regional networks
  - Address specific needs
  - Improve capacity
  - Improve regional coordination
  - Improve regional consistency

Regional Networks

Regional Networks

Networks…

The designation or name isn't important…

Each is a collection of tools deployed to provide information to answer a question

NAMS
SLAMS
PAMS
IMPROVE
NDN
MDN
TSAT
Focus Sites
RAIN
CASTNET
AirMon
STN ….

Networks…

The designation or name isn't important…

Each is a collection of tools deployed to provide information to answer a question

- **by parameter**
- **by area**
- **by question**

ELEMENTS

In the beginning, is the **Question:**

- What MUST I do?

Part 58

You **will** monitor.

App A and B- You **will** do a good job.

App C – You **will** use Reference and Equivalent methods

In the beginning, is the **Question**:

- What MUST I do?

Part 58

You **will** monitor.

App D- Sites should be here.

App E- The probe at the site should be…

App F- Report the data.

In the beginning, is the **Question**:

- What MUST I do?

Part 58

App D – Network Design for:

- **NAMS**
- **SLAMS**
- **PAMS**

Networks

- **SLAMS**
  - **State and Local Air Monitoring Stations**
- **NAMS**
  - **National Air Monitoring Stations**
- **SPMs**
  - **Special Purpose Monitors**
- **PAMS**
  - **Photochemical Assessment Monitoring Stations**

Networks

- **SLAMS**
  - **State and Local Air Monitoring Stations**
- **NAMS**
  - **National Air Monitoring Stations**
- **SPMs**
  - **Special Purpose Monitors**
- **PAMS**
  - **Photochemical Assessment Monitoring Stations**

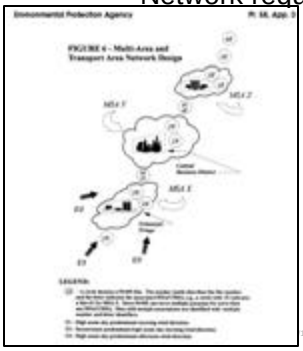
Monitoring 'Stations'

- **The SITE just the location..**
  - **monitors (or samplers) have an objective (not the site)**
  - **multiple objectives may be met at one location**

Network requirements Pt 58 App.D

- **Objectives**
  - **Max concentration**
  - **Representative exposure of population**
  - **Impacts of sources**
  - **Background**
  - **Transport**
  - **Welfare impacts in rural and remote areas**

Network requirements Pt 58 App.D



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Network requirements Pt 58 App.D

- **Objectives**

Each objective is associated with appropriate spatial scales of representativeness

- **Max concentration**
- **Representative exposure of population**
- **Impacts of sources**
- **Background**
- **Transport**
- **Welfare impacts in rural and remote areas**

Network requirements Pt 58 App.D

- **Scale**

'..physical dimensions… …throughout which actual pollutant concentrations are reasonably similar.'

- **Micro**
- **Middle**
- **Neighborhood**
- **Urban**
- **Regional**
- **National/Global**

'..physical dimensions…'

' …characterizing the nation and region as a whole.'

- Micro
- Middle
- Neighborhood
- Urban
- Regional
- **National**/Global

'..physical dimensions…'

'...rural area of reasonably homogeneous topography….tens to hundreds of kilometers.'

- Micro
- Middle
- Neighborhood
- Urban
- **Regional**
- National/Global

'..physical dimensions…'

'...on the order of 4 to 50 kilometers.

…usually require more than one site for definition.'

- Micro
- Middle
- Neighborhood
- **Urban**
- Regional
- National/Global

'..physical dimensions…'

'...relatively uniform land use with dimensions in the 0.5 to 4.0 kilometers range.'

- Micro
- Middle
- **Neighborhood**
- Urban
- Regional
- National/Global

'..physical dimensions…'

'...several city blocks…dimensions ranging from about 100 meters to 0.5 kilometer.'

- Micro
- **Middle**
- Neighborhood
- Urban
- Regional
- National/Global

'..physical dimensions…'

'... dimensions ranging from several meters to about 100 meters.'

- **Micro**
- Middle
- Neighborhood
- Urban
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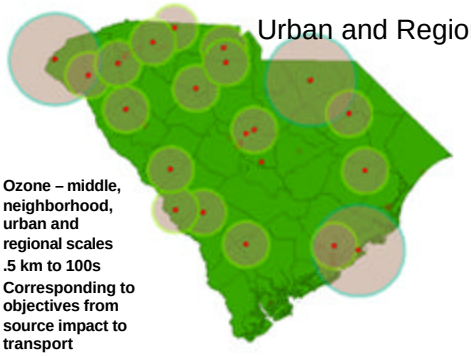
- National/Global

'..physical dimensions…'

Used for quality assurance (QA) to define the precision of the method.

- **Collocated**
- Micro
- Middle
- Neighborhood
- Urban
- Regional
- National/Global

Urban and Regional



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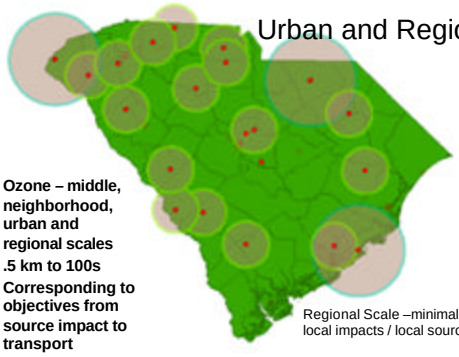
- **.5 km to 100s**
- **Corresponding to objectives from source impact to transport**

Urban and Regional



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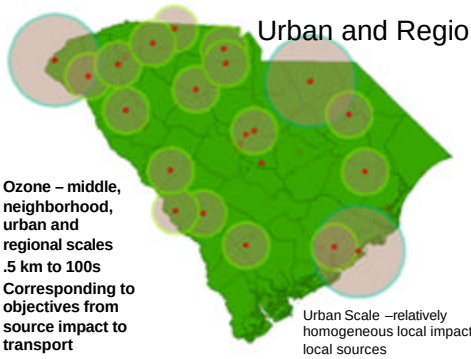
Regional Scale –minimal local impacts / local sources

Urban and Regional



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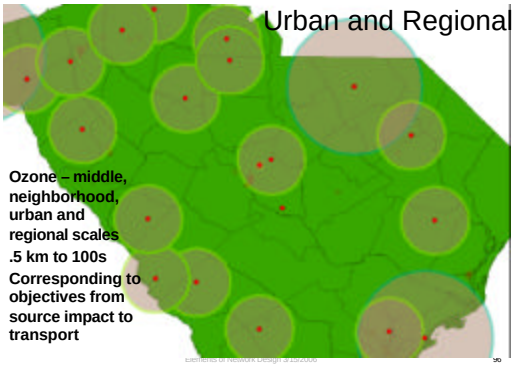
Urban Scale –relatively homogeneous local impacts / local sources

Urban and Regional



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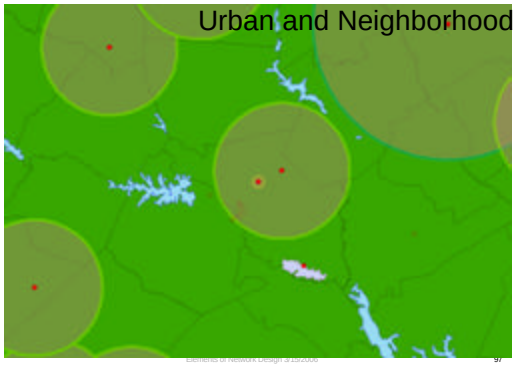

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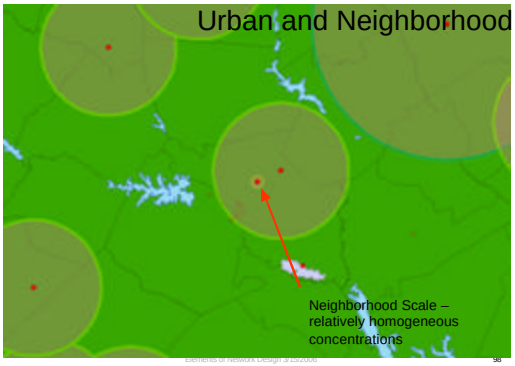

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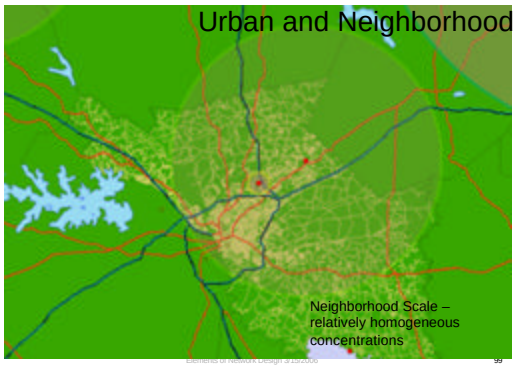

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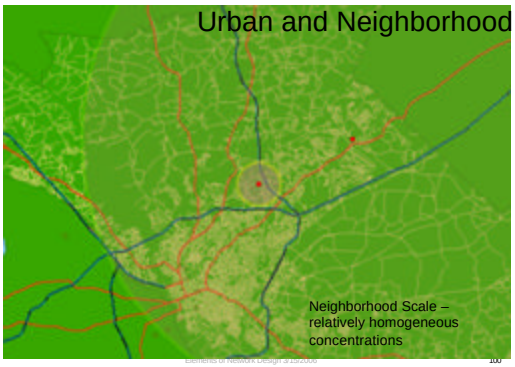

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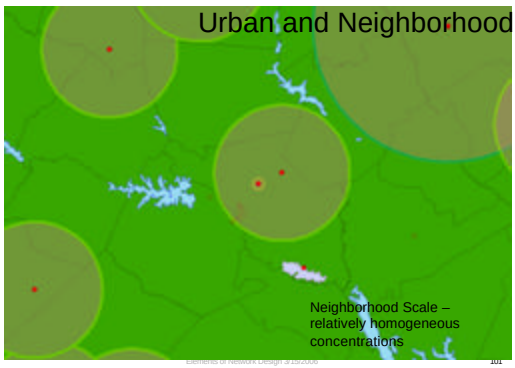
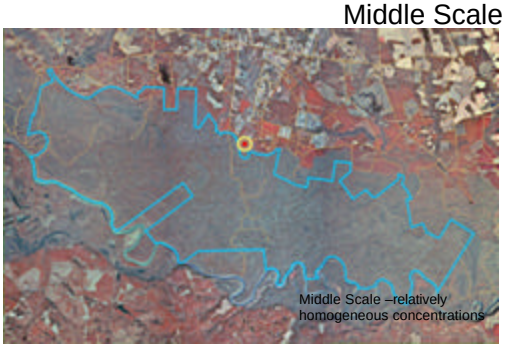
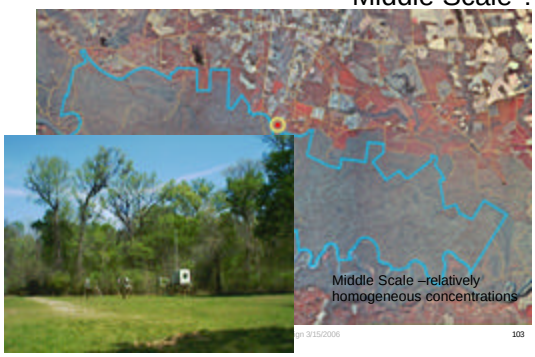


Middle Scale



Middle Scale ?

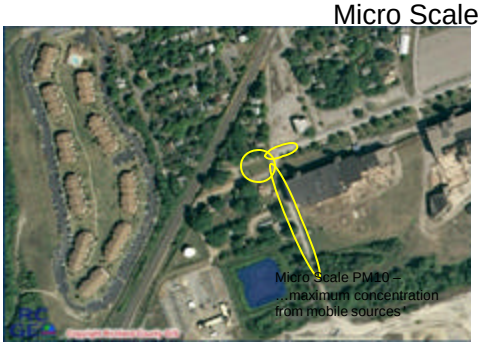


Middle Scale –relatively homogeneous concentrations

Micro Scale

Micro Scale PM10 – …maximum concentration from mobile sources'

Micro Scale

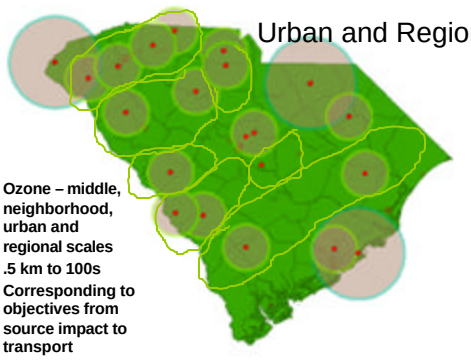


Micro Scale PM10 – …maximum concentration from mobile sources'

Micro Scale

Micro Scale PM10 – …maximum concentration from mobile sources'

Urban and Regional



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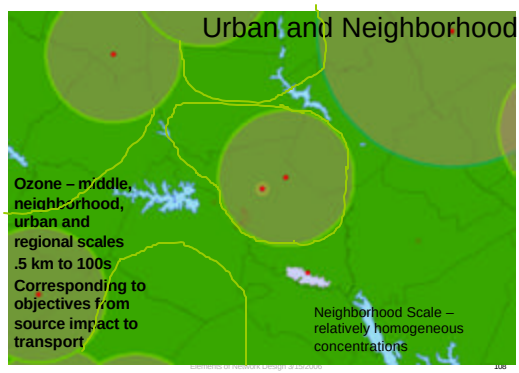
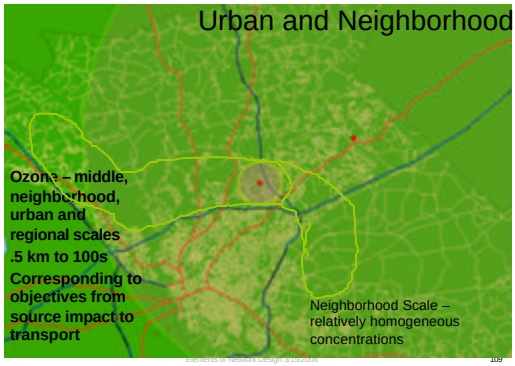


- **Ozone – middle, neighborhood, urban and regional scales**
- **.5 km to 100s**
- **Corresponding to objectives from source impact to transport**

Neighborhood Scale – relatively homogeneous concentrations

Urban and Neighborhood



- **Ozone – middle, neighborhood, urban and regional scales**
- **.5 km to 100s**
- **Corresponding to objectives from source impact to transport**

Scale

Each Objective has appropriate Scales

Table 1 - Relationship Among Monitoring Objectives and Scale of Representativeness

Monitoring Objective	Appropriate Siting Scales
Highest Concentration...	Micro, Middle, Neighborhood (sometimes Urban)
Population……	Neighborhood, Urban
Source Impact……	Micro, Middle, Neighborhood
General/background…..	Neighborhood, Urban, Regional
Regional Transport……	Urban / Regional
Welfare-related impacts.	Urban / Regional

'..representative…'

'...the spatial scale of representativeness is described in terms of the physical dimensions of the air parcel nearest to a monitoring station throughout which **actual pollutant concentrations are reasonably similar.'**

'..representative…'

'...reasonably similar.'

$PM_{2.5}$

'..relatively similar annual average air quality… similar day to day variability.
(average within 20% of area average and correlation greater than about .6)

Spatial Uniformity (PM guidance)
(Annual CV<10% , 20% max deviation)

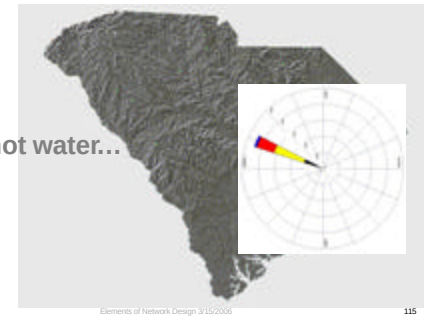
When evaluating or planning for '…reasonably…'relatively. …'representative … keep in mind:

When evaluating or planning for '…reasonably…'relatively. …'representative … keep in mind:

Topography matters, but
Air is not water…

When evaluating or planning for

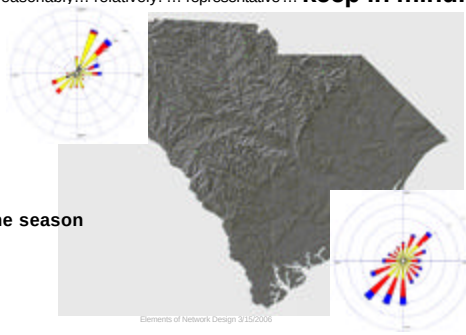
'…reasonably…'relatively. …'representative… **keep in mind:**



Air is not water…

When evaluating or planning for

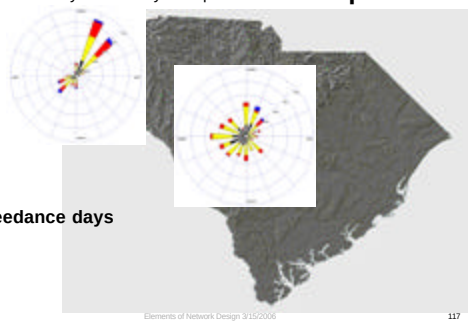
'…reasonably…'relatively. …'representative… **keep in mind:**



Ozone season

When evaluating or planning for

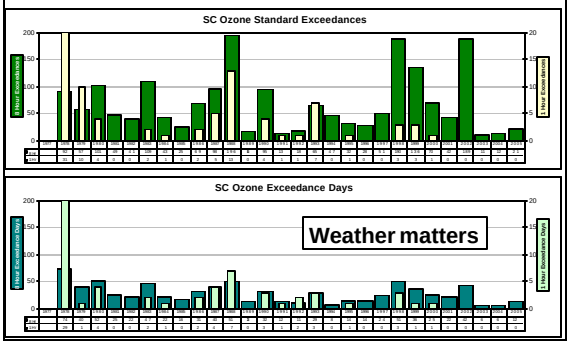
'…reasonably…'relatively. …'representative… **keep in mind:**



Exceedance days

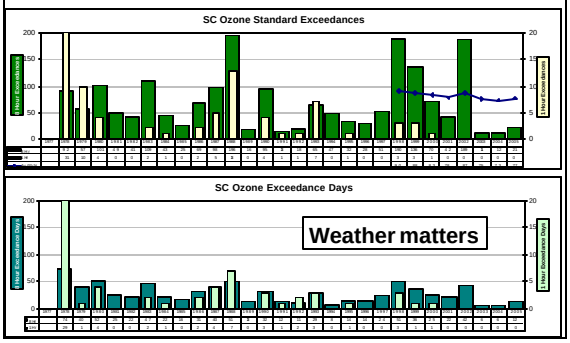
When evaluating or planning for

'…reasonably…'relatively. …'representative… **keep in mind:**



When evaluating or planning for

'…reasonably…'relatively. …'representative… **keep in mind:**



When evaluating or planning for

'…reasonably…'relatively. …'representative… **keep in mind:**

Like water, there are things that are in solution and things that will settle out.

When evaluating or planning for

'…reasonably…'relatively. …'representative… **keep in mind:**

Fewer variables that affect concentration are under control

Meteorology

Topography

Distribution (and movement) of sources

When evaluating or planning for

'…reasonably…'relatively. …'representative… **keep in mind:**

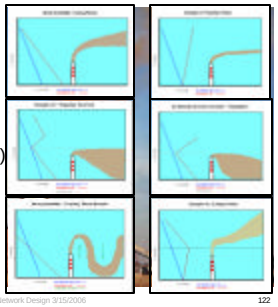
Fewer variables that affect concentration are under control

Meteorology

Topography

Distribution (and movement) of sources

Local meteorology can have a BIG impact



When evaluating or planning for

'…reasonably…'relatively. …'representative… **keep in mind:**

Sampling period is important…

and the appropriate period and aggregation depends on the objective..

When evaluating or planning for

'…reasonably…'relatively. …'representative… **keep in mind:**

Sampling period is important…

and the appropriate period and aggregation depends on the objective..

When evaluating or planning for

'…reasonably…'relatively. …'representative… **keep in mind:**

No two sites are identical.

- **Every measurement is a snapshot of that place, at that time..**

…and cannot be redone

When evaluating or planning for

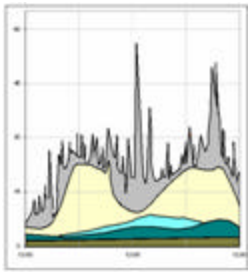
'…reasonably…'relatively. …'representative… **keep in mind:**

Every location is impacted by emissions from distant and nearby sources.

- **The relative contribution can change from minute to minute...**

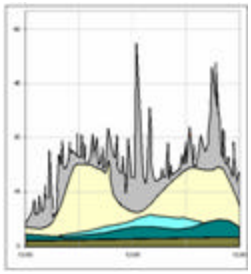
When evaluating or planning for '…reasonably…'relatively. …'representative … keep in mind:

- **The data can provide clues about the impacts at the monitor location.**



When evaluating or planning for '…reasonably…'relatively. …'representative … keep in mind:

- **In general, the closer the source(s), the greater the frequency and amplitude of the signal.**



Variability

- The idea of **representative scale** is used to help make sure the balance of impacts on the site match the objective.

Representative

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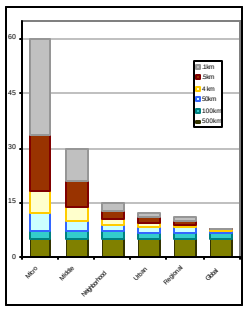
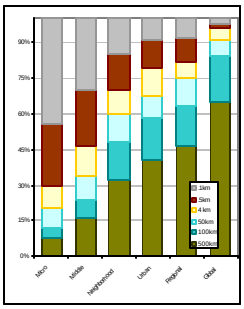


Representative

- The idea of **representative scale** is used to help make sure the balance of impacts on the site match the objective.

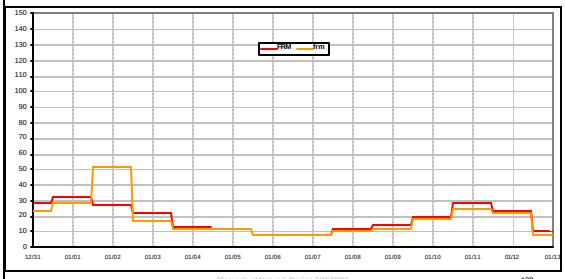


Spatially and Temporally Representative

- The data needs to be representative both over space and time.
  - •Averaging periods
  - •Multiple sites
  - •Long path methods

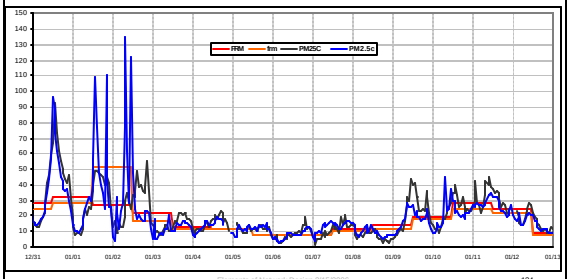
'…reasonably'…'relatively'…'representative…

Need to examine long term data



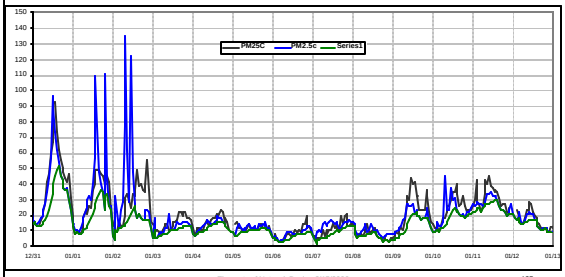
'…reasonably'…'relatively'…'representative…

Need to examine long term data



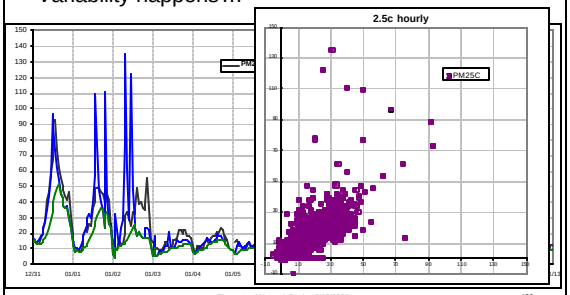
'…reasonably'…'relatively'…'representative…

Need to examine long term data



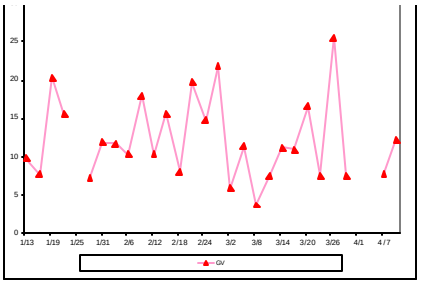
'…reasonably'…'relatively'…'representative…

Variability happens…



'…reasonably'…'relatively'…'representative…

Need to test assumptions



'…reasonably'…'relatively'…'representative…

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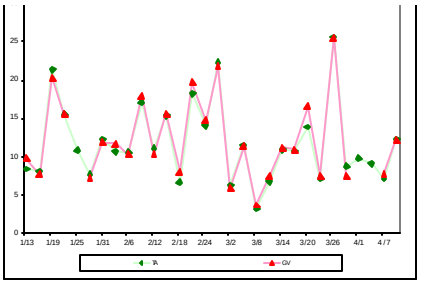
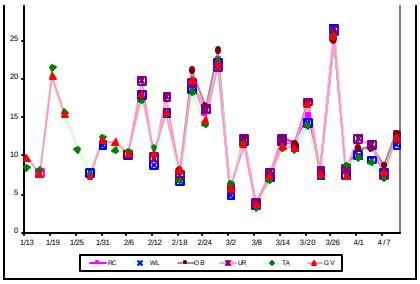


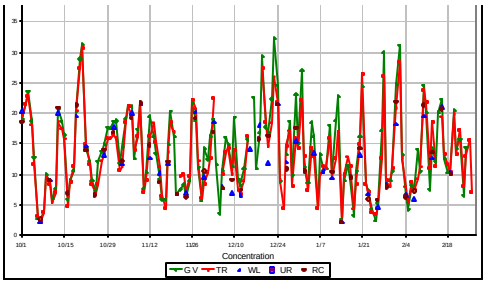
'…reasonably'…'relatively'…'representative…

Need to test assumptions



'…reasonably'…'relatively'…'representative…

(and possibly retest…)



'…reasonably'…'relatively'…'representative…

Need to test **all** assumptions.

TSP used 1:6 day sampling:

- ~65 samples a year
- 'unbiased' system
- every day of the week sampled equally
- consistent nationwide
- practical

'…reasonably'…'relatively'…'representative…

Need to test **all** assumptions.

$PM_{2.5}$ needed more samples to meet the data quality objectives of the national program – 1:3 ?:

- ~130 samples a year
- 'unbiased' system
- every day of the week sampled equally
- consistent nationwide
- practical

'…reasonably'…'relatively'…'representative…

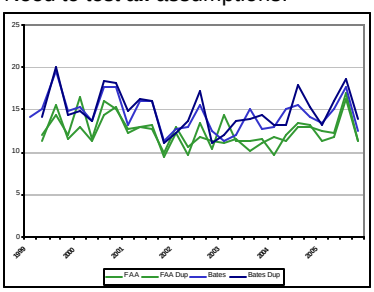
Need to test **all** assumptions.

$PM_{2.5}$ core samplers sampled 1:1 with a collocated sampler at 1:6 for QA.

- quarterly averages of collocated samplers more different than the precision would suggest.

'…reasonably'…'relatively'…'representative…

Need to test **all** assumptions.

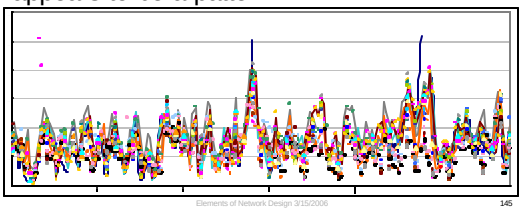


Hmmm…

'…reasonably'…'relatively'…'representative…

Need to test **all** assumptions.

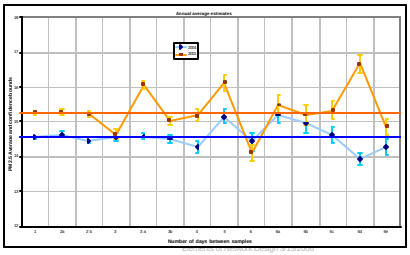
Now that we have lots of data for $PM_{2.5}$, there appears to be a pattern.



'…reasonably'…'relatively'…'representative…

Need to test **all** assumptions.

1:3 not guaranteed to be representative



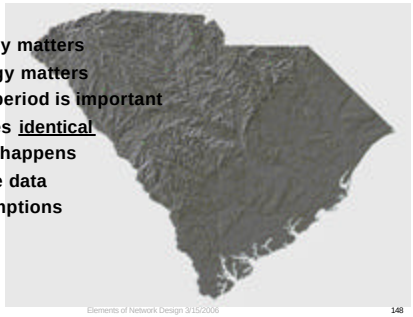
Spatially and Temporally Representative

- The data needs to be representative both over space **and** time.

When evaluating or planning for

'…reasonably…'relatively. …'representative… **keep in mind:**

Topography matters
Meteorology matters
Sampling period is important
No two sites identical
Variability happens
Look at the data
Test assumptions



When evaluating or planning for

'…reasonably…'relatively. …'representative… **keep in mind:**

Topography matters
Meteorology matters
Sampling period is important
No two sites identical
Variability happens
Look at the data
Test assumptions

Air is kinda like water..

When evaluating or planning for

'…reasonably…'relatively. …'representative… **keep in mind:**

Like water, there are things that are in solution and things that will settle out...

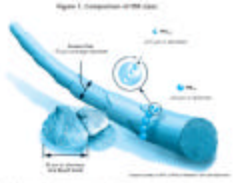
..and there are things that are inert and things that will change.

individual parameter characteristics

- **Gas**
  - **SO_2 NO_2, CO**
  - **May stay the same for long periods**
  - **May react and change quickly**
- Particles
- Primary
- Secondary

individual parameter characteristics

- Gas
- **Particles**
  - **TSP, PM_{10}, $PM_{2.5}$, Lead**
  - **The smaller it is, the more like a gas it behaves..**



individual parameter characteristics

- Gas
- **Particles**
  - **TSP, $PM_{10-2.5}$, $PM_{2.5}$, Lead**
  - **The smaller it is, the more like a gas it behaves..**
- Primary
- Secondary

individual parameter characteristics

- Gas
- Particles
- **Primary**
  - **Released and doesn't change (until it does)**
  - **CO, EC, soils, or Lead don't change (much)**
- Secondary

individual parameter characteristics

- Gas
- Particles
- Primary
- **Secondary**
  - **Changes, or is created in the atmosphere**
  - **Stuff reacts with moisture, light, other chemicals to produce the pollutant of concern.**

Network design criteria Pt 58

SLAMS

- **By Parameter**
  - **Appropriate scales**
  - **Types of locations**
  - **Objective**

More Network design criteria Pt 58

- **By Parameter**
  - Appropriate scales
  - Types of locations
  - Objective
  - Monitoring Season for Ozone

Ozone

Middle
- Close to NOx sources
- Watch the trees

Neighborhood
- Urban subregion
- Testing concepts and models
- May be high when stagnant

More Network design criteria Pt 58

- **By Parameter**
  - Appropriate scales
  - Types of locations
  - Objective

Carbon Monoxide

Micro
- Street canyons
- Hot spot

Middle
- Geometry of the rep. area (roads)
- Possibly parking lots..

More Network design criteria Pt 58

- **By Parameter**
  - Appropriate scales
  - Types of locations
  - Objective
  - Number of sites
    - By population
    - By objective

$PM_{2.5}$

Micro
- Street canyons
- Hot spot

Neighborhood
- Most pop exposure associated with this scale
- Assumed unless….

More Network design criteria Pt 58

- **By Parameter**
  - Appropriate scales
  - Types of locations
  - Objective
  - Number of sites
    - By population
    - By objective
  - Encouraged spatial averaging

$PM_{2.5}$

Core

2 per MSA > 500,000

1 per MSA > 200,000

'…more than minimum should be deployed..'

Also:

Regional Background

Transport

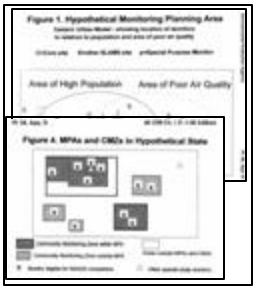
1 per each 200,000 outside MSAs

More Network design criteria Pt 58

- **By Parameter**
  - Appropriate scales
  - Types of locations
  - Objective
  - Number of sites
    - By population
    - By objective
  - Encouraged spatial averaging

More Network design criteria Pt 58

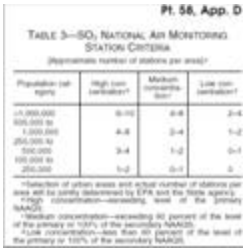
- **By Parameter**
  - Appropriate scales
  - Types of locations
  - Objective
  - Number of sites
    - By population
    - By objective
  - Encouraged spatial averaging



More Network design criteria Pt 58

NAMS

- **By Parameter**
  - **Specify minimum numbers**
  - **By population and concentration**



Pt. 58, App. D

TABLE 3—SO_2 NATIONAL AIR MONITORING STATION CRITERIA

(Approximate number of stations per area)*

Population (all ages)	High concentration†	Medium concentration‡	Low concentration†
>1,000,000	0–10	4–8	2–4
500,000 to 1,000,000	4–8	2–4	1–2
250,000 to 500,000	3–4	1–2	0–1
100,000 to 250,000	1–2	0–1	0

*Selection of urban areas and actual number of stations per area will be jointly determined by EPA and the State agency.
†High concentration—exceeding 80 percent of the level of the primary or 100% of the secondary NAAQS.
‡Low concentration—less than 80 percent of the level of the primary or 100% of the secondary NAAQS.

More Network design criteria Pt 58

Helpful summary tables…

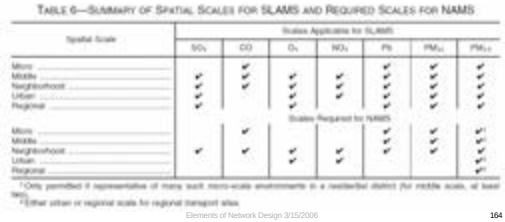


TABLE 6—SUMMARY OF SPATIAL SCALES FOR SLAMS AND REQUIRED SCALES FOR NAMS

Spatial Scale	Scales Applicable for SLAMS: SO_2	CO	O_3	NO_2	Pb	PM_{10}	$PM_{2.5}$
Micro	✔	✔	✔	✔	✔	✔	✔
Middle	✔	✔	✔	✔	✔	✔	✔
Neighborhood	✔	✔	✔	✔	✔	✔	✔
Urban	✔	✔	✔	✔	✔	✔	✔
Regional	✔	✔	✔	✔	✔	✔	✔
	Scales Required for NAMS						
Micro		✔			✔	✔	✔[1]
Middle	✔	✔	✔	✔	✔	✔	✔[1]
Neighborhood							✔[1]
Urban							✔[1]
Regional							✔[1]

[1]Only permitted if representative of many such micro-scale environments in a residential district (for middle scale, at least two).
[2]Either urban or regional scale for regional transport area.

SC Network

NAMS

SC Network

SLAMS

Network design criteria Pt 58

Our Helpful summary tables…

	SO_2	CO	Ozone	NO_2	Lead	PM_{10}	$PM_{2.5}$
NAMS	1	-	5	-	-	2	(5)*
SLAMS	3	1	12	3	4	12	10
SPMs	8	3	4	4	17	4	12

Network design criteria Pt 58

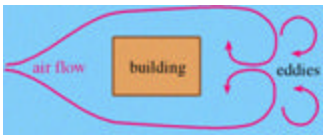
- **NAMS intended to**
  - **..provide data for national policy analysis/trends and for reporting to the public on major metropolitan areas.**
  - **Comparison to the standards**

Site requirements

- **To increase the probability that the specific site will be reasonably representative**
  - **General**
    - **Free air flow**
      - **prevailing winds, obstructions**
    - **No local sources that unduly impact**
    - **Probe location- height, distance from sources**

Site requirements

- **Free air flow- consider impact of …**
  - **Buildings**
  - **Walls**
  - **Trees**



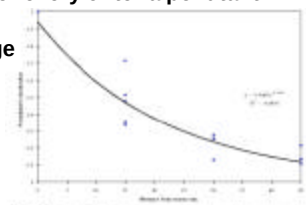
Consider predominant wind direction and sources (in the context of the objective)

Site requirements

- **Probe location - ideally in the breathing zone, but consider:**
  - **Characteristics of the pollutant**
  - **Scale**
  - **Objective**
  - **Operation of the site**

Site requirements

- **Probe location - distance from roadways.**
  - **Chart or graph for every criteria pollutant except SO_2**
  - **Based on average daily traffic**



Site requirements

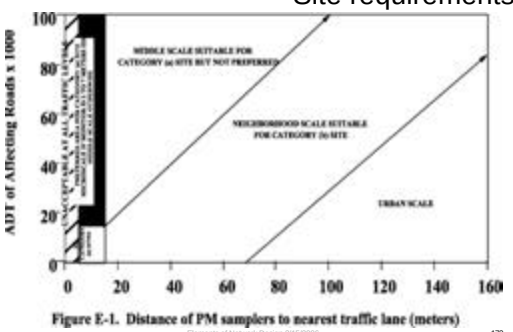


Figure E-1. Distance of PM samplers to nearest traffic lane (meters)

Probe?

Probe?

Probe Siting Criteria

Site requirements

- **To increase the probability that the specific site will be reasonably representative**
  - **General**
  - **Specific**
    - **A pollutant may have specific needs to ensure collection of consistent, unbiased data.**
    - **Probe material**
    - **interferences**

Site requirements

Guidance documents for PM, SO_2, Ozone, Lead (and some noncriteria**) available.**

Links on DHEC web site, Ambient Air Network page

Ozone - Guideline on Ozone Monitoring Site Selection EPA-454/R -98-002 August 1998
PM - Guidance for Network Design and Optimum Site Exposure for PM2.5and PM10 EPA-454/R -99-022 December 1997
SO_2 - Optimum Site Exposure Criteria for SO2 Monitoring EPA-450/3 -77-013 April 1977
Lead -Guidance forSiting Ambient Air Monitors Around Stationary Lead Sources EPA-454/R -92-009R, August 1997
PSD - Ambient Monitoring Guidelines for Prevention of Significant Dete rioration (PSD) EPA-450/4 -87-007 May1987
Noncriteria - Network Design and Site Exposure Criteria for SelectedNoncriteria Air Pollutants EPA-450/4 -84-022 September 1984
Ozone Precursors - Site Selection for the Monitoring of Photochemical Air Pollutants, April 1978
Visibility - Visibility Monitoring Guidance EPA-454/R -99-003 June 1999

Guidance

- **Quality Assurance**
  - **Redbook (Quality Assurance Handbook for Air Pollution Measurement Systems EPA 600/9-76-005)**

Network Design

Strike a balance between:

- **Omniscient**
  - **everywhere, all the time**
- **The minimum**
- **Be Practical…**
  - **make (and test) assumptions**
  - **use representative sites**
  - **bias towards worst case**
  - **maximize resources**

Sampling/Monitoring strategies

- **Random**
- **Judgmental**
- **Stratified**
- **Systemic (Grid)**
- **Ranked**
  - **Professional judgment**
- **Adaptive Cluster**
  - **Adjust as you learn**

Because we have some information in the beginning ..

- Pollutant sources
- Characteristics
- Data
- Models

…we can use the best blend of techniques to plan

Sampling/Monitoring strategies

- **Random**
- **Judgmental**
- **Stratified**
- **Systemic (Grid)**
- **Ranked**
  - **Professional judgment**
- **Adaptive Cluster**
  - **Adjust as you learn**
- **Required**

Because we have some information in the beginning ..

- Pollutant sources
- Characteristics
- Data
- Models

…we can use the best blend of techniques to plan.

PROCESS

Process

- **Network Design**
  - **Starting from scratch..**
  - **New pollutant or special study**
- **Review / Assessment**
  - **Existing Network**
  - **Meeting requirements?**
  - **Meeting needs?**

Process

- **Process similar**
  - **Assemble team**
  - **Check requirements**
  - **Analyze the data**
  - **Determine needs**
  - **Make recommendations**
  - **Prioritize**
  - **Draft the plan**
  - **Address comments**
  - **Implement**

Process

- **Process similar**
  - Assemble team
  - Check requirements
  - Analyze the data
  - Determine needs
  - Make recommendations
  - Prioritize
  - Draft Monitoring Plan
  - Address comments
  - Implement

The biggest difference in design and assessment is that more data is available for assessment.

Process

- **Assemble the team**
  - Monitoring
  - Meteorology
  - Modeling
  - Data
  - Permitting
  - Planning
  - Community Liaison

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  - Monitoring
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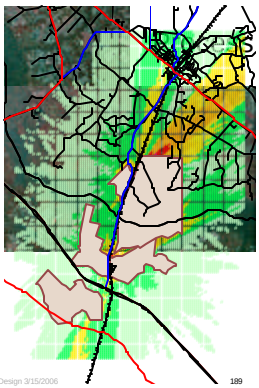


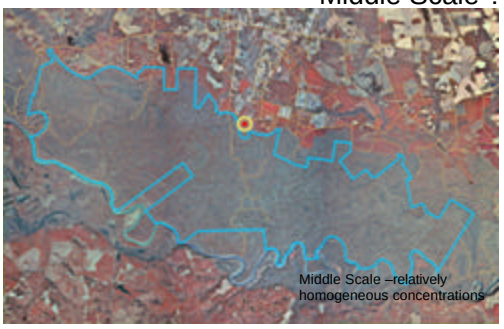
Process

- **Check against the Rule…**
  - Requirements met?
  - Intent met?
  - Deficiencies Addressed?

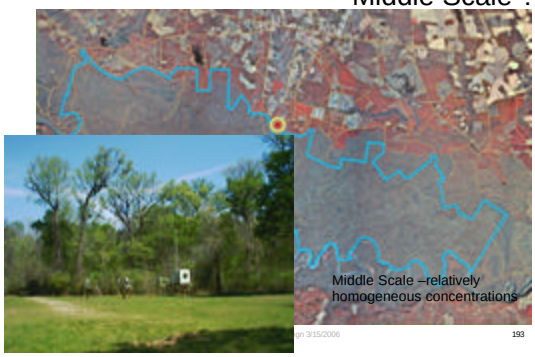
Process

- **Check against the Rule…**
- **Analyze the data**
  - Catch the easy stuff
  - Analysis may raise more questions

Middle Scale ?



Middle Scale ?



Middle Scale ?

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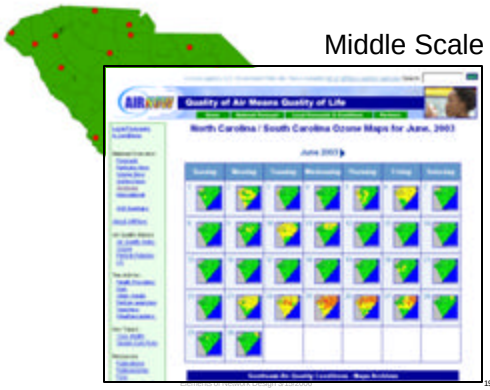
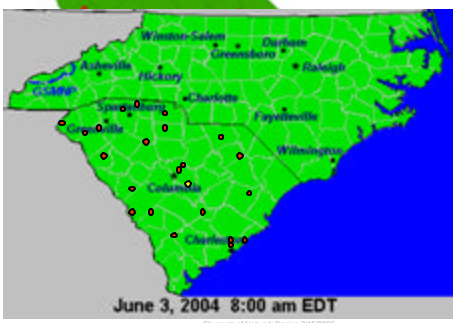
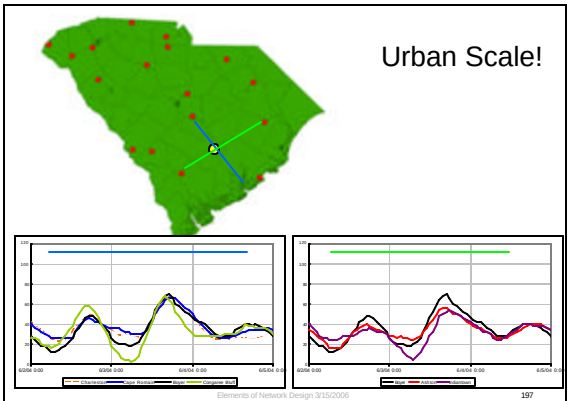


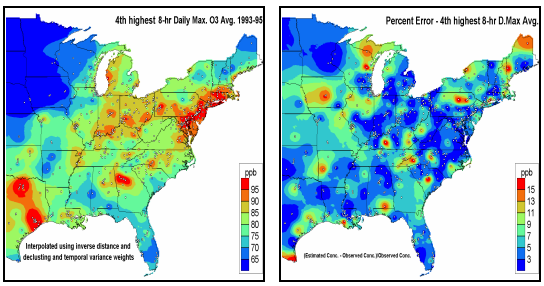
Middle Scale ?



Urban Scale!



Base case ozone surface all sites Error surface after site rem

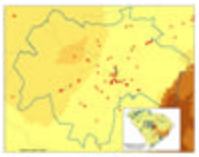


Process

- Check against the Rule…
- **Analyze the data**
  - **Gather resources**
  - **Catch the easy stuff**
  - **Analysis may raise more questions**

Review

- **Resources**
  - **Requirements**
  - **Objectives (network and site specific)**
  - **Network description**
  - **Site descriptions**
  - **Air quality summaries**
  - **Access to data**
  - **Emissions inventory and trends**
  - **Area Climatology/Typical Site Meteorology**
  - **Population trends**
  - **Projections**
  - **Enforcement actions**
  - **Maps**
    - » ***Network***
    - » ***Sources***
    - » ***Population***
    - » ***Topography***
  - **Previous Reviews**
    - » ***Region 4 Assessment of Ambient Air Monitoring Networks (Final 2005)***



Process

- Check against the Rule…
- Analyze the data
- **Assemble the questions**
  - **Synchronize and prioritize**

Process

- **What are the Questions to be answered? - Questions drive the design.**

Process

What are the Questions to be answered? - Questions drive the design.

- **Compliance**
  - **Highest concentration**
  - **population density- in particular when in vicinity of high concentration**
  - **air quality entering the area**
  - **areas of projected growth**
  - **evaluation of control strategies**
  - **represent all areas**

Process

What are the Questions to be answered? - Questions drive the design.

- **Emergency**
  - **in densely populated areas**
  - **near large sources**
  - **near sensitive populations (hospitals, schools, etc.)**
  - **near high traffic density**

Process

What are the Questions to be answered? - Questions drive the design.

- **Trends - a few sites representing large spatial scales**
  - **background**
  - **context**
  - **minimal local source impact**

Process

What are the Questions to be answered? - Questions drive the design.

- **Research**
  - **Health effects**
  - **Fate of pollutants**
  - **Development of tools**
    - **Models**
    - **Source apportionment**

Process

What are the Questions to be answered? - Questions drive the design.

- **Health effects**
  - **in or near population being studied**
  - **averaging times appropriate for acute or chronic exposure and effect**
  - **typically higher frequency (daily or less)**

Process

What are the Questions to be answered? - Questions drive the design.

- **Pollutant studies**
  - **formation and reaction**
  - **precursors / intermediates**
  - **sources**

Process

What are the Questions to be answered? - Questions drive the design.

- **Planning**
  - **Source apportionment**
  - **Effectiveness of control measures**

Process

- **Questions (no order)**
  - Required number of monitors and reflecting the regulations' intent for NAAQS?
  - Required monitors for all special monitoring networks (speciation, visibility, toxics)?
  - Operating according to documented requirements?
  - How long since last review?
  - Designation status and timing?
  - Do results of special studies indicate need for change?
  - Are there proposed or impending network modifications?
  - Are there current or expected changes in population, emissions, land use?
  - Do NAAQS changes require review and realignment of monitoring?
  - Are some populations /areas poorly represented?
  - Is there redundancy in the network?
  - ?

Process

- **Develop and understand the monitoring objective(s) and appropriate Data Quality Objectives**

Process

- **Identifying the spatial and temporal scale most appropriate for the site monitoring objective**
  - **Spatial**
    - **Max concentration - Micro, Middle, Neighborhood, Urban (rarely)**
    - **Max exposure to population- Neighborhood, Urban**
    - **Impacts of sources - Micro, Middle, Neighborhood**
    - **Transport- Urban, Regional**
    - **General/Background- Neighborhood, Regional**
    - **Welfare -Urban, Regional**

Process

- **Identifying the spatial and temporal scale most appropriate for the site monitoring objective**
  - **Temporal**
    - **Continuous - = 1 hr - local source/acute effects**
    - **Integrated**
      - ***temporal - = 1hr - = 24 hour samples***
      - ***spatial - open path***
    - **Static- exposure samplers- special studies**

Process

- **Identify the general locations where the monitoring site should be placed**
  - **Impacts of known emissions and sources at site**
  - **Representativeness of site (appropriate to intended scale)**
  - **Pollutant specific concerns**
  - **Topography**

Process

- **Identify specific monitoring sites**
  - **Availability (public property?)**
  - **Cost**
  - **Safety/Security**
  - **Logistics**
  - **Access**
  - **Utilities (Power, Communication)**
  - **Duration of availability**
  - **Meteorology**
  - **Topography**

Process

- **Process**
  - **Assemble team**
  - **Check requirements**
  - **Determine needs**
  - **Analyze the data**
  - **Make recommendations**
  - **Prioritize**
  - **Draft Monitoring Plan**
  - **Address comments**
  - **Implement**

Process

- **Process**
  - **Assemble team**
  - **Check requirements**
  - **Determine needs**
  - **Analyze the data**
  - **Make recommendations**
  - **Prioritize**
  - **Draft Monitoring Plan**
  - **Address comments**
  - **Implement**

..And in parallel

- **Identify Stakeholders**
- **Provide Training**
- **Provide access to resources**
- **Gather input**
- **Identify opportunities**

Process

- **Stakeholders identified**
  - **Air Program**
  - **Environment**
  - **Resource Managers**
  - **Health**
  - **Communities**
  - **Business**
  - **Research**

Process

- **Provide Training (this meeting)**

Process

- **Provide Training (this meeting)**
- **Provide resources**
  - **Web Page**
  - **Request**

Process

- **Provide Training (this meeting)**
- **Provide resources**
- **Gather input**
  - **Air Program planning needs**
  - **Stakeholder questions**

Process

- **Provide Training (this meeting)**
- **Provide resources**
- **Gather input**
- **Define required networks**

Process

- Provide Training (this meeting)
- Provide resources
- Gather input
- Define required networks
- **Identify needs beyond the required**
  - **identify**
  - **prioritize**

Process

- Provide Training (this meeting)
- Provide resources
- Gather input
- Define required networks
- Identify needs beyond the required
- **Draft Monitoring Plan**
  - **Comment**
  - **Revise**

Process

- Provide Training (this meeting)
- Provide resources
- Gather input
- Define required networks
- Identify needs beyond the required
- **Draft Monitoring Plan**

Complete network assessment due by July 1, 2007

Process

- Provide Training (this meeting)
- Provide resources
- Gather input
- Define required networks
- Identify needs beyond the required
- Draft Monitoring Plan
- **Implement**

Process

- **Repeat**

Process

- **Regular complete network review**
  - **By parameter**
    - **minimums met**
    - **objectives addressed**
    - **revisions addressed in Monitoring Plan**
  - **By area**
    - **MSA?**
    - **minimums met**
    - **needs met**

Practical

The perfect site is not available…

- **Where you plan vs. where you can..**
  - **Access**
  - **Permission**
  - **Exposure**
  - **Time**
  - **Cost**

- **Where you plan vs. where you can..**
  - **Access**
  - **Permission**
  - **Exposure**
  - **Time**
  - **Cost**

If an existing site can reasonably be used to meet the objective, you will probably **use it.**

- **Where you plan vs. where you can..**
  - **Access**
  - **Permission**
  - **Exposure**
  - **Time**
  - **Cost**

If an existing site still serves the objective, try to **preserve it.**

Reality check

- **Can you pay your way..?**
  Every data point collected has a cost.
  - **Equipment**
  - **Infrastructure**
  - **Personnel**
  - **Operation**
  - **Utilities**
  - **QA**
  - **Data Management**
  - **Reporting**

Reality check

- **Can you pay your way..?**
  Every data point collected has a cost.
  - **Equipment**
  - **Infrastructure**
  - **Personnel**
  - **Operation**
  - **Utilities**
  - **QA**
  - **Data Management**
  - **Reporting**

Some times the incremental cost for useful data is small.
Do it.

Reality check

- **Can you pay your way..?**
  Every data point collected has a cost.
  - **Equipment**
  - **Infrastructure**
  - **Personnel**
  - **Operation**
  - **Utilities**
  - **QA**
  - **Data Management**
  - **Reporting**

Individual sites -

- **Can you pay your way..?**
  Every data point collected has a cost.
  - **Equipment**
  - **Infrastructure**
  - **Personnel**
  - **Operation**
  - **Utilities**
  - **QA**
  - **Reporting**
  - **Data Management**

Good Science

To answer the question you need:

- **The right data**
  - **Quality Assurance Project Plan (QAPP)**
- **Data of known quality**
  - **Precise**
  - **Accurate**
- **Unbiased data**
  - **Quality Assurance (QA)**

EQC Quality Management Plan (QMP)

Finally…..

Philosophy

- **Be sure we support the DHEC mission:** *We promote and protect the health of the public and the environment***' by:**

Philosophy

- **Be sure we support the DHEC mission:** *We promote and protect the health of the public and the environment***' by:**
  - **Collecting data representative of exposure of the general population**

Philosophy

- **Be sure we support the DHEC mission:** *We promote and protect the health of the public and the environment***' by:**
  - **Collecting data representative of exposure of the general population <u>Representative</u>**

Philosophy

- **Be sure we support the DHEC mission:** *We promote and protect the health of the public and the environment***' by:**
  - **Collecting data representative of exposure of sensitive populations**

Philosophy

- **Be sure we support the DHEC mission:** *We promote and protect the health of the public and the environment***' by:**
  - **Collecting data representative of exposure of sensitive populations <u>Worst Case</u>**

Philosophy

- **Be sure we support the DHEC mission:** *We promote and protect the health of the public and the environment***' by:**
  - **Providing context**
    - **Adequate representation of the state**
      - ***Population centers***
      - ***Small cities and rural areas***
      - ***Pristine areas***
    - **Measurement continuity**

Philosophy

- **Be sure we support the DHEC mission:** *We promote and protect the health of the public and the environment***' by:**
  - **Providing data of known quality**
    - **Measurement consistency**
    - **Measurement transparency**

Philosophy

- **Be sure we support the DHEC mission:** *We promote and protect the health of the public and the environment***' by:**
  - **Providing data that supports understanding**

Philosophy

- **Be sure we support the DHEC mission:** *We promote and protect the health of the public and the environment***' by:**
  - **Providing data that supports understanding**
    - **Sources**
    - **Precursors**
    - **Fate**
    - **Data Analysis**

Philosophy

We promote and protect the health of the public and the environment

The data is the is the standard by which the success of our effort is measured.

Questions?